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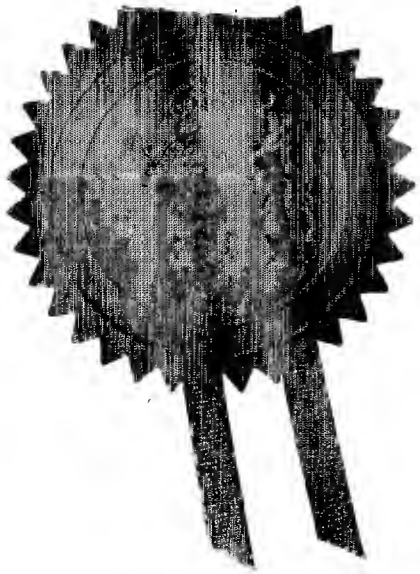

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Patents Form 1/77

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Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office
Cardiff Road
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1. Your reference — P367651/JED/DBR/JAL

2. Patent application number *(The Patent Office will fill this part in)* — 0405471.4 — 11 MAR 2004

3. Full name, address and postcode of the or of each applicant *(underline all surnames)* — DES Enhanced Recovery Limited
Westhill Business Centre
Amhall Business Park
Westhill, Aberdeen, AB32 6US

Patents ADP number *(if you know it)* — 8642258001

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention — "Apparatus and Method for Recovering Fluids From A Well"

5. Name of your agent *(if you have one)* — Murgitroyd & Company

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)* — 165-169 Scotland Street
Glasgow
G5 8PL

Patents ADP number *(if you know it)* — 1198013

6. Priority: Complete this section if you are declaring priority from one or more earlier patent applications, filed in the last 12 months.

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*
United Kingdom		

7. Divisionals, etc: Complete this section only if this application is a divisional application or resulted from an entitlement dispute (see note f)

Number of earlier UK application	Date of filing *(day / month / year)*

8. Is a Patents Form 7/77 (Statement of inventorship and of right to grant of a patent) required in support of this request? — Yes

Answer YES if:
a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
Otherwise answer NO (See note d)

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Patents Form 1/77

9. Accompanying documents: A patent application must include a description of the invention. Not counting duplicates, please enter the number of pages of each item accompanying this form:

Continuation sheets of this form	-
Description	20
Claim(s)	-
Abstract	-
Drawing(s)	3 only

10. If you are also filing any of the following, state how many against each item.

Priority documents	-
Translations of priority documents	-
Statement of inventorship and right to grant of a patent (Patents Form 7/77)	-
Request for a preliminary examination and search (Patents Form 9/77)	-
Request for a substantive examination (Patents Form 10/77)	-
Any other documents (please specify)	-

11. I/We request the grant of a patent on the basis of this application.

Signature(s) Date 11/03/04

12. Name, daytime telephone number and e-mail address, if any, of person to contact in the United Kingdom

Jamie Allan
01224 706616

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Notes

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b) Write your answers in capital letters using black ink or you may type them.

c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.

d) If you have answered YES in part 8, a Patents Form 7/77 will need to be filed.

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f) Part 7 should only be completed when a divisional application is being made under section 15(4), or when an application is being made under section 8(3), 12(6) or 37(4) following an entitlement dispute. By completing part 7 you are requesting that this application takes the same filing date as an earlier UK application. If you want the new application to have the same priority date(s) as the earlier UK application, you should also complete part 6 with the priority details.

Apparatus and Method for recovering fluids from a well

The present invention relates to an apparatus and method for diverting fluids.

It is common for a subsea well to have a christmas tree on the seabed and for this christmas tree to have a choke located in the production wing branch. Production fluids flow up the production bore, into the production wing branch, through the choke, and out of an outlet of the production wing branch into an outlet header, from where the fluids are conveyed away, for example, to the surface. Wells and trees are often active for a long time, and so wells from a decade ago may still be in use today. However, technology has progressed a great deal during this time, for example, subsea processing of fluids is now desirable. Such processing can involve adding chemicals, separating water and sand from the hydrocarbons, etc. Furthermore, it is sometimes desired to take fluids from one well and inject a

component of these fluids into another well. To do any of these things involves breaking the pipework attached to the outlet of the wing branch, inserting new pipework leading to this processing equipment, alternative well, etc. This provides the problem and large associated risks of disconnecting pipe work which has been in place for a considerable time, and which was never intended to be disconnected. Furthermore, due to environmental regulations, no produced fluids are allowed to leak out into the ocean, and any such unanticipated and unconventional disconnection provides the risk that this will occur.

According to a first aspect of the present invention there is provided a diverter assembly for a christmas tree, comprising a housing having an internal passage, wherein the diverter assembly is adapted to be attached to a choke body so that the internal passage of the diverter assembly is in communication with the interior of the choke body.

The invention provides the advantage that fluids can be diverted from their usual path between the well bore and the outlet of the wing branch. The fluids may be produced fluids being recovered and travelling from the well bore to the outlet. Alternatively, the fluids may be injection fluids travelling in the reverse direction into the well bore. As the choke is standard equipment, there are well-known and safe techniques of removing and replacing the choke as it wears out. The same tried

and tested techniques can be used to remove the choke from the choke body and to clamp the diverter assembly onto the choke body, without the risk of leaking well fluids into the ocean. This enables new pipe work to be connected to the choke body and hence enables safe re-routing of the produced fluids, without having to undertake the considerable risk of disconnecting and reconnecting any of the existing pipes (e.g. the outlet header).

Some embodiments allow fluid communication between the well bore and the diverter assembly. Other embodiments allow the well bore to be separated from a region of the diverter assembly. The choke body may be a production choke body or an annulus choke body. The well bore may be a production bore or an annulus bore.

Preferably, a first end of the diverter assembly is provided with a clamp for attachment to a choke body.

Optionally, the housing is cylindrical and the internal passage extends axially through the housing between opposite ends of the housing. Alternatively, one end of the internal passage is in a side of the housing.

Typically, the flow diverter assembly includes separation means to provide two separate regions within the flow diverter assembly. Typically, each of these regions has a respective inlet and outlet

so that fluid can flow through both of these regions independently.

Optionally, the housing includes an axial insert portion.

Typically, the axial insert portion is in the form of a conduit. Typically, the end of the conduit extends beyond the end of the housing. Preferably, the conduit divides the inside of the diverter assembly into a first region formed by the bore of the conduit and a second region formed by the annulus between the housing and the conduit. Optionally, the conduit is adapted to seal within the inside of a choke body to prevent fluid communication between the annulus and the bore of the conduit.

Alternatively, the axial insert portion is in the form of a stem. Optionally, the axial insert portion is provided with a plug adapted to block an outlet of the christmas tree. Preferably, the plug is adapted to fit within and seal inside a passage leading to an outlet of a branch of the christmas tree.

Optionally, the diverter assembly provides means for diverting fluids from a first portion of a first flowpath to a second flowpath, and means for diverting the fluids from a second flowpath to a second portion of a first flowpath.

According to a second aspect of the present invention there is provided a christmas tree having a choke body and a diverter assembly; wherein the diverter assembly comprises a housing having an internal passage, and wherein the diverter assembly is attached to the choke body so that the internal passage of the diverter assembly is in communication with the interior of the choke body.

The choke body may be a production choke body or an annulus choke body. The well bore may be a production bore or an annulus bore.

Optionally, the diverter assembly is attached to the choke body by a clamp.

Optionally, the christmas tree has a wing branch and a wing branch outlet, and the internal passage of the diverter assembly is in fluid communication with the wing branch outlet. Optionally, a region defined by the diverter assembly is separate from the production bore of the well. Optionally, the internal passage of the diverter assembly is separated from the well bore by a closed valve in the christmas tree.

Alternatively, the diverter assembly is provided with an insert in the form of a conduit which defines a first region comprising the bore of the conduit, and a second separate region comprising the annulus between the conduit and the housing. Optionally, one end of the conduit is sealed inside

the choke body to prevent fluid communication between the first and second regions.

Optionally, the annulus between the conduit and the housing is closed so that the annulus is in communication with the wing branch only.

Alternatively, the annulus has an outlet for connection to further pipes, so that the second region provides a flowpath which is separate from the first region formed by the bore of the conduit.

Optionally, the first and second regions are connected by pipework. Optionally, a processing apparatus is connected in the pipework so that fluids are processed whilst passing through the connecting pipework.

Typically, the processing apparatus is selected from at least one of the group consisting of: a pump; a process fluid turbine; injection apparatus for injecting gas or steam; chemical injection apparatus; a fluid riser; measurement apparatus; temperature measurement apparatus; flow rate measurement apparatus; constitution measurement apparatus; consistency measurement apparatus; gas separation apparatus; water separation apparatus; solids separation apparatus; and hydrocarbon separation apparatus.

Optionally, the diverter assembly provides a barrier to separate the wing branch outlet from the wing

branch. Optionally, the barrier comprises a plug, which is typically located inside the choke body to block the wing branch outlet. Optionally, the plug is attached to the housing by a stem which extends axially through the internal passage of the housing.

Alternatively, the barrier comprises a conduit of the diverter assembly which is engaged within the choke body.

Optionally, the christmas tree is provided with a conduit connecting the first and second regions.

According to a third aspect of the present invention, there is provided a method of diverting fluids, comprising: attaching a diverter assembly to a choke body of a christmas tree, wherein the diverter assembly comprises a housing having an internal passage, so that the internal passage of the diverter assembly is in communication with the interior of the choke body; and diverting the fluids through the housing.

Optionally, the christmas tree includes a wing branch and a wing branch outlet and the diverter assembly provides a barrier which separates the wing branch outlet from the rest of the wing branch.

Optionally, the method is used to recover produced fluids from a well by diverting produced fluids from the production bore, through the internal passage in

the diverter assembly to an aperture in the diverter assembly.

Alternatively, the method is used to inject fluids into a well, by delivering fluids through an aperture in the diverter assembly, through the internal passage and the choke body, and into the well.

Alternatively, the method is used to divert fluids between the wing branch outlet and the aperture of the diverter assembly. The fluids may be passed in either direction through the diverter assembly, so that the aperture of the diverter assembly comprises an inlet or an outlet.

Typically, the flow diverter assembly includes separation means to provide two separate flow regions within the flow diverter assembly, and the method includes the step of passing fluids through both of these regions.

Typically, the housing of the diverter assembly has an extension portion in the form of an interior conduit extending internally through the housing, the bore of the conduit defining a first flow region, and the annulus between the conduit and the housing defining a second flow region, each of the first and the second flow regions having a respective inlet and outlet, and the method includes the step of passing fluids through both of the first and the second flow regions.

Optionally, fluids are passed through the first and the second flow regions in the same direction. Alternatively, fluids are passed through the first and the second flow regions in opposite directions.

Optionally, the fluids are passed through one of the first and second flow regions and subsequently at least a proportion of these fluids are then passed through the other of the first and the second flow regions. Optionally, the method includes the step of processing the fluids in a processing apparatus before passing the fluids back to the other of the first and second regions.

Optionally, the first and second regions are connected by pipework. Optionally, a processing apparatus is connected in the pipework so that fluids are processed whilst passing through the connecting pipework.

Typically, the processing apparatus is selected from at least one of the group consisting of: a pump; a process fluid turbine; injection apparatus for injecting gas or steam; chemical injection apparatus; a fluid riser; measurement apparatus; temperature measurement apparatus; flow rate measurement apparatus; constitution measurement apparatus; consistency measurement apparatus; gas separation apparatus; water separation apparatus; solids separation apparatus; and hydrocarbon separation apparatus.

Typically, the method includes the step of removing a choke from the choke body before attaching the diverter assembly to the choke body.

Optionally, the method includes the step of diverting fluids from a first portion of a first flowpath to a second flowpath and diverting the fluids from the second flowpath to a second portion of the first flowpath.

The method provides the advantage that fluids can be diverted (e.g. recovered or injected into the well, or even diverted from another route, bypassing the well completely) without having to remove and replace any pipes already attached to the wing branch outlet.

According to a fourth aspect of the invention there is provided a flow diverter assembly comprising a conduit adapted to be inserted within a christmas tree branch bore, such that the bore of the conduit defines a first region and the annulus between the conduit and the christmas tree branch bore defines a second region.

Preferably, each of the first and the second region has a respective inlet and outlet, so fluids can flow through both of these regions.

An embodiment of the invention will now be described, by way of example only, and with reference to the following drawings, in which:-

Fig 1 shows a cross-sectional view of a first embodiment of a diverter assembly;

Fig 2 shows a cross-sectional view of a second embodiment of a diverter assembly;

Fig 3 shows a cross-sectional view of a third embodiment of a diverter assembly; and

Fig 4 shows a cross-sectional view of a fourth embodiment of a diverter assembly.

Fig 1 shows a diverter assembly 10 which is attached to a choke body 12, which is located in the production wing branch 14 of a christmas tree 16. The production wing branch 14 has an outlet 18, which is located adjacent to the choke body 12. The diverter assembly 10 is attached to the choke body 12 by a clamp 19. A first valve V1 is located in the central bore of the christmas tree and a second valve V2 is located in the production wing branch 14.

The choke body 12 is a standard subsea choke body from which the original choke has been removed. The choke body 12 has a bore which is in fluid communication with the production wing branch 14. The upper end of the bore of the choke body 12

terminates in an aperture in the upper surface of the choke body 12. The lower end of the bore of the choke body communicates with the bore of the production wing branch 14 and the outlet 18.

The diverter assembly 10 has a cylindrical housing 20, which has an interior axial passage 22. The lower end of the axial passage 22 is open; i.e. it terminates in an aperture. The upper end of the axial passage 22 is closed, and a lateral passage 26 extends from the upper end of the axial passage 22 to an outlet 24 in the side wall of the cylindrical housing 20.

The diverter assembly 10 has a stem 28 which extends from the upper closed end of the axial passage 22, down through the axial passage 22, where it terminates in a plug 30. The stem 28 is longer than the housing 20, so the lower end of the stem 28 extends beyond the lower end of the housing 20. The plug 30 is shaped to engage a seat in the choke body 12, so that it blocks the part of the production wing branch 14 leading to the outlet 18. The plug therefore prevents fluids from the production wing branch 14 or from the choke body 12 from exiting via the outlet 18. The plug is optionally provided with a seal, to ensure that no leaking of fluids can take place.

Before fitting the diverter assembly 10 to the tree 16, a choke is typically present inside the choke body 12 and the outlet 18 is typically connected to

an outlet conduit, which conveys the produced fluids away e.g. to the surface. Produced fluids flow through the bore of the christmas tree 16, through valves V1 and V2, through the production wing branch 14, and out of outlet 18 via the choke.

The diverter assembly 10 can be retrofitted to a well by closing one or both of the valves V1 and V2 of the christmas tree 16. This prevents any fluids leaking into the ocean whilst the diverter assembly 10 is being fitted. The choke (if present) is removed from the choke body 12 by a standard removal procedure known in the art. The diverter assembly 10 is then clamped onto the top of the choke body 12 by the clamp 19 so that the stem 28 extends into the bore of the choke body 12 and the plug 30 engages a seat in the choke body 12 to block off the outlet 18. Further pipework (not shown) is then attached to the outlet 24 of the diverter assembly 10. This further pipework can now be used to divert the fluids to any desired location. For example, the fluids may be then diverted to a processing apparatus, or a component of the produced fluids may be diverted into another well bore to be used as injection fluids. Further examples of processing apparatus are described in more detail below.

The valves V1 and V2 are now re-opened which allows the produced fluids to pass into the production wing branch 14 and into the choke body 12, from where they are diverted from their former route to the outlet 18 by the plug 30, and are instead diverted

through the diverter assembly 10, out of the outlet 24 and into the pipework attached to the outlet 24.

Although the above has been described with reference to recovering produced fluids from a well, the same apparatus could equally be used to inject fluids into a well, simply by reversing the flow of the fluids. Injected fluids could enter the diverter assembly 10 at the aperture 24, pass through the diverter assembly 10, the production wing branch 14 and into the well. Although this example has described a production wing branch 14 which is connected to the production bore of a well, the diverter assembly 10 could equally be attached to an annulus choke body connected to an annulus wing branch and an annulus bore of the well, and used to divert fluids flowing into or out from the annulus bore.

Fig 2 shows an alternative embodiment of a diverter assembly 10' attached to the christmas tree 16, and like parts will be designated by like numbers having a prime. The christmas tree 16 is the same christmas tree 16 as shown in Fig 1, so these reference numbers are not primed.

The housing 20' in the diverter assembly 10' is cylindrical with an axial passage 22'. However, in this embodiment, there is no lateral passage, and the upper end of the axial passage 22' terminates in an aperture 30' in the upper end of the housing 20', so that the upper end of the housing 20' is open.

Thus, the axial passage 22' extends all of the way through the housing 20' between its lower and upper ends. The aperture 30' can be connected to external pipework (not shown).

Fig 3 shows a further alternative embodiment of a diverter assembly 10'', and like parts are designated by like numbers having a double prime. This figure is cut off after the valve V2; the rest of the christmas tree is the same as that of the previous two embodiments. Again, the christmas tree of this embodiment is the same as those of the previous two embodiments, and so these reference numbers are not primed.

The housing 20'' of the Fig 3 embodiment is substantially the same as the housing 20' of the Fig 2 embodiment. The housing 20'' is cylindrical and has an axial passage 22'' extending therethrough between its lower and upper ends, both of which are open. The aperture 30'' can be connected to external pipework (not shown).

The housing 20'' is provided with an extension portion in the form of a conduit 32'', which extends from near the upper end of the housing 20'', down through the axial passage 22'' to a point beyond the end of the housing 20''. The conduit 32'' is therefore internal to the housing 20'', and defines an annulus 34'' between the conduit 32'' and the housing 20''.

The lower end of the conduit 32'' is adapted to fit inside a recess in the choke body 12, and is provided with a seal 36, so that it can seal within this recess, and the length of conduit 32'' is determined accordingly.

As shown in Fig 3, the conduit 32'' divides the space within the choke body 12 and the diverter assembly 10'' into two distinct and separate regions. A first region is defined by the bore of the conduit 32'' and the part of the production wing bore 14 beneath the choke body 12 leading to the outlet 18. The second region is defined by the annulus between the conduit 32'' and the housing 20''/the choke body 12. Thus, the conduit 32'' forms the boundary between these two regions, and the seal 36 ensures that there is no fluid communication between these two regions, so that they are completely separate.

In use, the embodiments of Figs 2 and 3 function in substantially the same way. The valves V1 and V2 are closed to allow the choke to be removed from the choke body 12 and the diverter assembly 10', 10'' to be clamped on to the choke body 12, as described above with reference to Fig 1. Further pipework leading to desired equipment is then attached to the aperture 30', 30''. The diverter assembly 10', 10'' can then be used to divert fluids in either direction therethrough between the apertures 18 and 30', 30''. In the Fig 2 embodiment, there is the option to divert fluids into or from the well, if

the valves V1, V2 are open, and the option to exclude these fluids by closing at least one of these valves. In the Fig 3 embodiment, no fluids can enter or leave the well, due to the seal 36; this embodiment can only be used to divert fluids up or down the conduit 32''. The Fig 3 embodiment provides the additional security of a third barrier formed by the seal 36, against any fluids leaking out of the well. The Fig 2 embodiment can be used to recover fluids from or inject fluids into a well. The Fig 2 and Fig 3 embodiments may equally be clamped to an annulus choke body of an annulus wing branch leading to an annulus bore of a well, rather than the production choke body and production wing branch illustrated here.

Fig 4 shows a further embodiment of a diverter assembly which is similar to the Fig 3 embodiment, and like parts are designated with like reference numbers having a triple prime. The difference from the Fig 3 embodiment is that the annulus 34''' between the conduit 32''' and the housing 20''' is open at its upper end, leading to an aperture 38''' in the side wall of the housing 20'''. This embodiment provides a first flow region defined by the bore of the conduit 32''' and a second flow region defined by the annulus 34'''. Since the annulus 34''' is in communication with the wing branch and the aperture 38''', fluids can also flow in the second flow region. As the first and second regions are separated from each other by the conduit 32''', simultaneous flow in the first and second

flow regions may take place. The flow may be in the same direction, or different directions.

Optionally, the apertures 30''' and 38''' may be connected by pipework (not shown) so that fluids may flow through one of the flow regions, through the pipework, and then through the other of the flow regions. Flow could take place in either direction, depending on whether recovery or injection of fluids is required. Optionally, the fluids could pass via a processing apparatus located in the pipework connecting the first and the second flow regions. Optionally, only a proportion or a component of the fluids could be returned to the other of the first and the second flow regions after processing to remove the rest of the fluids. For example, produced fluids (a combination of hydrocarbons, water and sand) could be recovered from a well via the annulus 34''', processed to separate the hydrocarbons from the water and sand, and only the hydrocarbons could be returned to the bore of the conduit 32''' for recovery. To inject fluids, the flow direction could be reversed.

Thus, the invention provides a means for diverting the fluids from a first portion of a first flowpath (e.g. the annulus 34''') to a second flowpath (e.g. the pipework connecting the aperture 38''' to the aperture 30''') and a means for diverting the fluids from the second flowpath to a second portion of the first flowpath (e.g. the bore of the conduit 32''').

These embodiments have the advantage of providing a safe way to connect further pipework to the well, without having to disconnect any of the existing pipework, and without a significant risk of fluids leaking from the well into the ocean.

Modifications and improvements may be incorporated without departing from the scope of the invention. For example, as stated above, the diverter assembly could be attached to an annulus choke body, instead of to a production choke body.

The uses of the invention are very wide ranging. The further pipework attached to the flow diverter assembly could lead to an outlet header, an inlet header, a further well, or some processing apparatus (not shown). The processing apparatus itself could be one or more of a wide variety of equipment. For example, the processing apparatus could comprise a pump or process fluid turbine, for boosting the pressure of the fluid. Alternatively, or additionally, the processing apparatus could inject gas or steam into the well fluids. The injection of gas could be advantageous, as it would give the fluids "lift", making them easier to pump. The addition of steam has the effect of adding energy to the fluids.

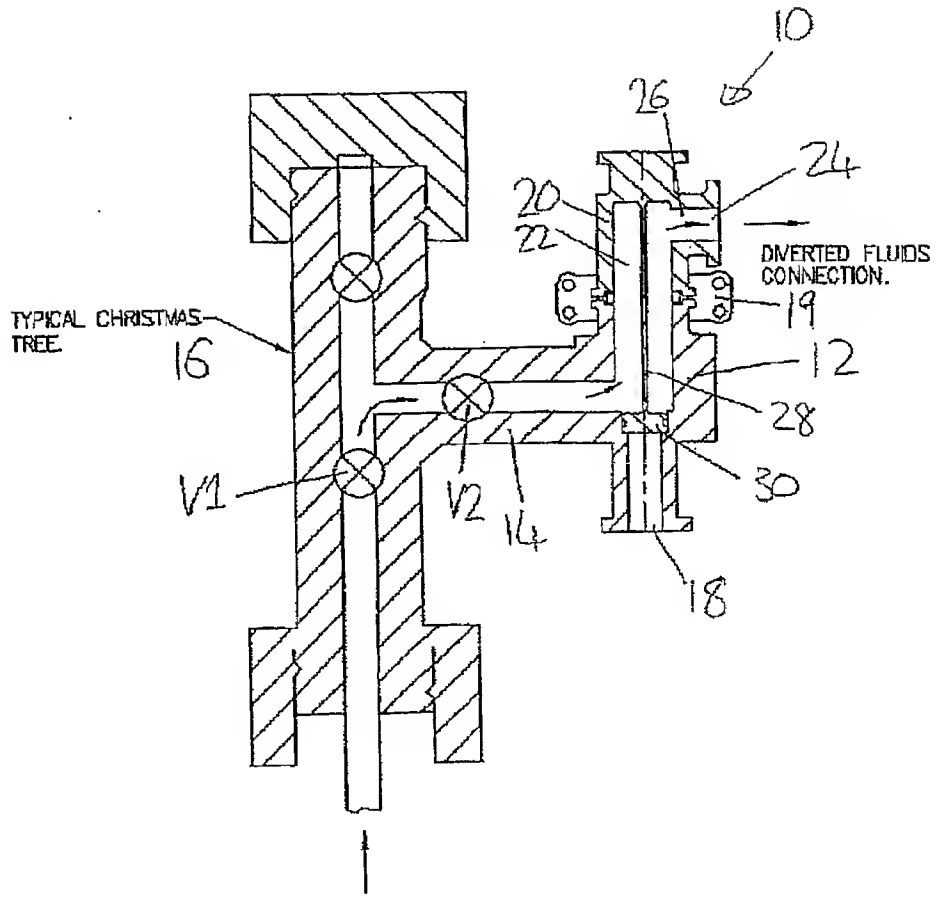
The processing apparatus could also enable chemicals to be added to the well fluids, e.g. viscosity moderators, which thin out the produced fluids, making them easier to pump, or pipe skin friction

moderators, which minimise the friction between the fluids and the pipes. The chemicals/ injected materials could be added via one or more additional input conduits. The processing apparatus could also comprise a fluid riser, which could provide an alternative route to the surface for the produced fluids. The processing equipment could alternatively or additionally include measurement apparatus, e.g. for measuring the temperature/flow rate/constitution/ consistency, etc. The separation equipment may be adapted to separated gas, water, sand/debris and/or hydrocarbons.

Many of these processes may never have been envisaged when the christmas tree was originally installed, and the invention provides the advantage of being able to adapt these existing trees in a low cost way without risking leaks.

MARS CHOKE INSERT WELL FLUID DIVERTER.

Fig 1



MARS CHOKE FLOWLINE FLUID DIVERTER.

Fig 2

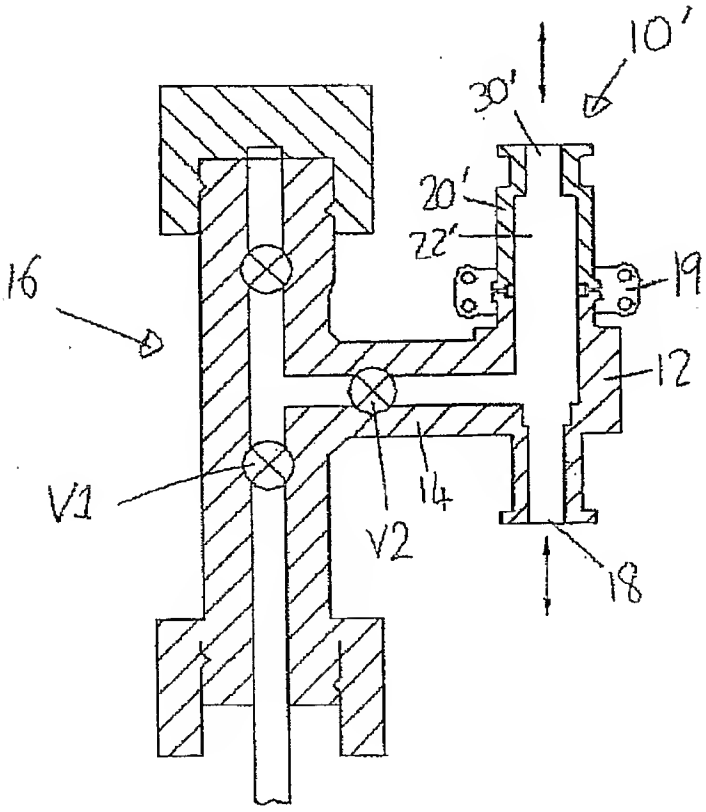
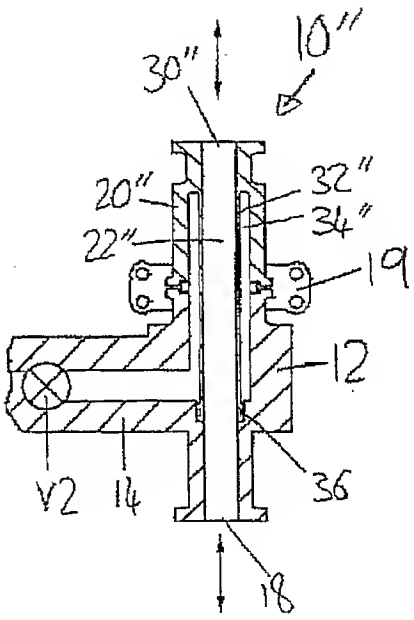


Fig 3



MARS CHOKE FLOWLINE FLUID DIVERTER.

Fig 4